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ABSTRACT

Differences in articulation error rates and error patterns as a function of five elicitation modes (picture, picture with pretraining, word repetition, sentence repetition, and nonsense word repetition) were examined. The same 15 words (or pictures representing them) were stimuli in four real word conditions; nonsense words were formed by recombining the vowels and final consonants of the real words. Subjects were 22 preschoolers, 8 kindergarteners, 10 first graders, and 24 college students. Each subject was tested in each mode with order of testing counterbalanced. Errors in initial consonants, initial consonant clusters, vowels, final consonants, and final consonant clusters were scored separately. Error rates and error patterns were similar for the four real word modes. The nonsense words showed an error rate three times higher than that of the real word modes and, in constrast with the real word modes, increased rather than decreased from initial to final position. The effect of test items which are effectively nonsense as well as additional considerations bearing on the choice of real word testing modes are also considered. Tables and references are included. (Author/VJ)

THE EFFECT OF ELICITATION IN ARTICLATION TESTING

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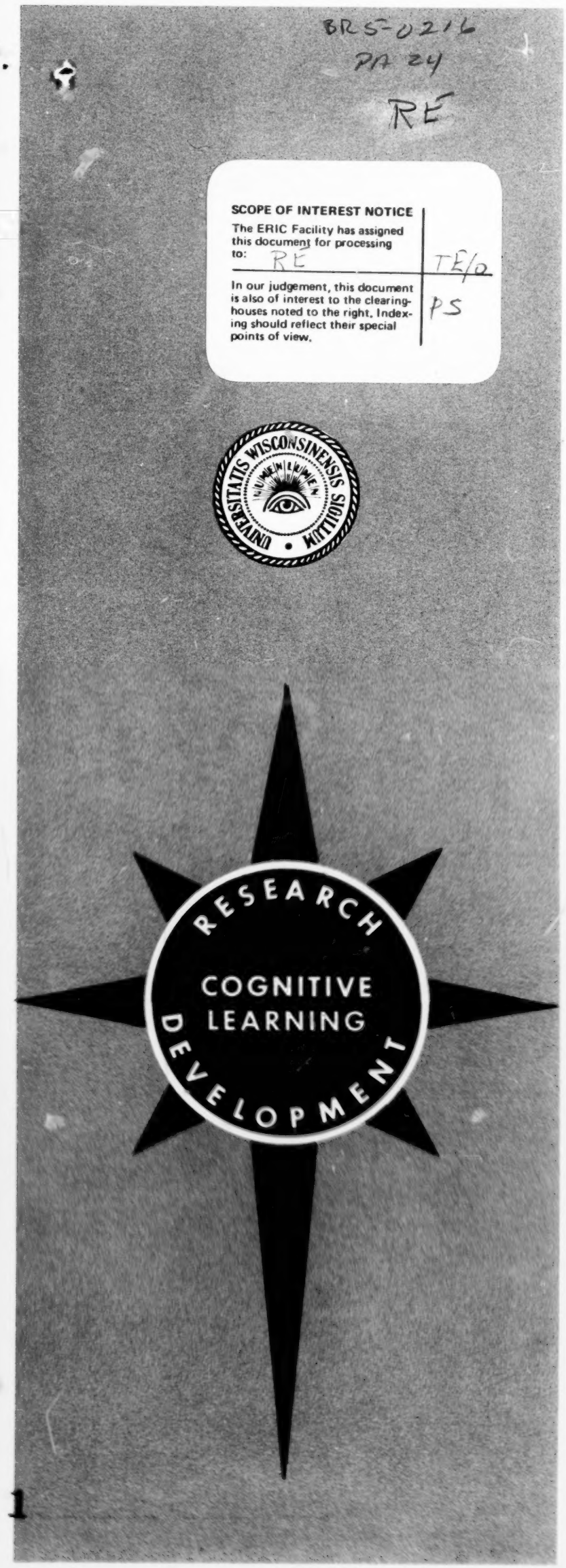

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Technical Report No. 154

THE EFFECT OF MODE OF ELICITATION IN ARTICULATION TESTING

Robin S. Chapman and Ai chen Ting

Report from the Project on Reading and Related Language Arts
Basic Prereading Skills: Identification and Improvement

R. L. Venezky, Principal Investigator

Wisconsin Research and Development
Center for Cognitive Learning
The University of Wisconsin
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This Technical Report is from the Basic Prereading Skills: Identification and Improvement element of the Reading and Related Language Arts Project in Program 2, Processes and Programs of Instruction. General objectives of the Program are to develop curriculum materials for elementary and preschool children, to develop related instructional procedures, and to test and refine the instructional programs incorporating the curriculum materials and instructional procedures. Contributing to these Program objectives, this element has two general objectives: (1) to investigate ways to test for skill deficits and to overcome them and (2) to develop a kindergarten-level program, including diagnostic tests and instructional procedures, for teaching basic prereading skills. Tests and instructional programs will be developed for visual and acoustic skills, including letter and letter-string matching with attention to order, orientation and detail, and acoustical matching, segmentation, and blending.

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ABSTRACT

Differences in articulation error rates and error patterns were examined as a function of five elicitation modes: picture, picture with pretraining, word repetition, sentence repetition, and nonsense word repetition. The same 15 words (or pictures representing them) were used as stimuli in the four real word conditions; nonsense words were formed by recombining the vowels and final consonants of the real words.

Subjects (*S*s) were 22 preschoolers, 8 kindergartners, 10 first graders, and 24 college students. Each *S* was tested in each mode with order of testing counterbalanced. Errors in initial consonants, initial consonant clusters, vowels, final consonants, and final consonant clusters were scored separately.

Error rates and error patterns were similar for the four real word modes. The nonsense words showed an error rate three times higher than that of the real word modes and, in contrast with the real word modes, increased rather than decreased from initial to final position.

The effect of test items which are effectively nonsense is discussed for normative and correlative studies. Additional considerations bearing on the choice of real word testing modes are presented.

I
INTRODUCTION

In testing articulation, the experimenter or clinician must decide how speech sounds are to be elicited from the child; this paper is concerned with some of the consequences of that decision.

Speech sounds may be elicited spontaneously by pictures, incomplete sentences, printed words or sentences, or conversation. The spontaneous mode may have the advantage of eliciting normal, or habitual, speech patterns, if this is the experimental goal; it has the disadvantage, in younger children and poor readers, of failing to sample phonemes occurring in non-picturable or hard-to-read words.

Speech sounds may also be elicited by asking the child to repeat words, phrases, sentences, or nonsense words. The imitation mode permits the testing of a wider range of phonemes; however, it has been argued that the child may indeed imitate the model, revealing what he can say rather than what he normally says.

Evidence that imitative elicitation techniques yield lower error rates than spontaneous is mixed. In a study of 100 normal children with a mean age of 3 years 9 months, Templin (1947) found no differences between spontaneous (picture) and imitation modes for words. Siegel, Winitz, and Conkey (1963), in a study of 100 normal kindergartners, reported a slightly lower error rate on imitation for only eight out of 40 speech sounds or clusters (/-l, -r-, sk-, -š, r-, tr-, -č, -z/).

In studies of young, functionally speech-defective children (second grade or below), Morrison (1914) and Burkhard (1965) reported no difference in spontaneous (picture) and imitative modes; Fitschen (1965) and Snow and Milisen (1954), however, found fewer errors in imitation. Snow and Milisen also tested seventh and eighth grade children with functional speech defects and found the difference in spontaneous and imitation modes to be far greater for older children than younger.

Several other variations in test materials and procedure may affect error rates. For young speech-defective children, Fitschen (1965) and Burkhard (1965) found that the imitation of phrases or sentences produced higher error rates than imitation of single words. Scott and Milisen (1954), in a study of 64 functionally speech-defective children ranging in age from 4 to 14, found imitation of nonsense syllables (CV) to yield lower error rates than spontaneous elicitation of words, and further, that imitation error rates were lower when the child could see the experimenter saying the nonsense syllable than when the child could only hear the syllable. The effect of nonsense (or unfamiliar) words on normal children's articulation errors has not been investigated, although makers of imitation tests have attempted to use only high-frequency words.

Venezky, Chapman, and Calfee (in preparation), in a study of the articulation errors of normal kindergarten and first grade children, found error rates higher for repetition of words presented on tape than for repetition of words spoken by an experimenter facing the child. Higher error rates were observed for one speaker (female) on tape than the other (male).

It would appear that the following factors affecting error rate must be taken into account in interpreting differences in mode of elicitation: population from which sample is drawn (age; normal versus functionally speech defective); task (spontaneous production versus imitation); stimulus characteristics (real word, sentence, nonsense word); presentation, for imitation tasks (tape; live, experimenter's face concealed or visible); the environment of the speech sound tested (word or utterance initial, medial, and final; occurrence in diphthong or cluster); and the phonemes tested.

In the present study, the particular phonemes tested and their word positions and cluster environments were held constant; the effect on error rate of picture, word, sentence, and nonsense word elicitation modes was studied for four age groups of normal, monolingual speakers (preschool, kindergarten, first grade, and college). Of particular interest were possible differences in imitation mode conditions.

II
METHOD

DESIGN

A 4 x 5 x 5 factorial design was used: group x mode x sound class, with repeated measures on the last two factors. The four groups of *S*s participating in the study were preschoolers, kindergartners, first graders, and college students. Each *S* was tested in five elicitation mode conditions: picture, picture again, real word, nonsense word, and sentence. Five classes of sounds were defined for each stimulus list: initial consonant, initial consonant cluster, final consonant, final consonant cluster, and vowel.

STIMULUS MATERIALS

Fifteen common nouns representing concrete objects were drawn from articulation test lists used in a previous study; all were of intermediate pronunciation difficulty for kindergarten and first grade children (Venezky, Chapman, & Calfee, in preparation). Five sets of stimulus materials were derived from these words: two sets of slides which were color photographs of the 15 objects named (picture conditions 1 and 2); the word list itself; 15 nonsense words formed by permuting the vowels and final consonants or consonant clusters of the original test items; and 15 sentences of 6 words or less each containing an embedded test word.[1] The real words, nonsense words, and sentences used are listed in Table 1.

[1]One final consonant in the nonsense list was incorrectly recorded as /l/ rather than /r/.

Table 1

Stimulus Materials

Sentences	Words and Pictures	Nonsense Words
I drank a glass of milk.	glass	/glət/
The long string broke.	string	/stræθ/
The king's crown is silver.	crown	/krɪl/
The frog jumped into the water.	frog	/fræŋ/
Grandma gave me a scarf today.	scarf	/skaʊs/
His new shirt is blue.	shirt	/šəθ/
Susie's mouth is open.	mouth	/marf/
My truck has four wheels.	truck	/tram/
They built a church over there.	church	/čɔs/
A star twinkled in the sky.	star	/staʊəz/
My thumb hurts very much.	thumb	/θaʊk/
Daddy brought flowers home.	flowers	/flaʊg/
Sandy got a blouse for Christmas.	blouse	/bluč/
My tooth fell out.	tooth	/təs/
The grass grows fast in summer.	grass	/grən/

Each of the five sets of stimuli were independently random-ordered. The verbal materials were recorded on an Ampex 1100 tape recorder with a Shure lavaliere microphone at 3 1/2 ips by a male speaker of Midwestern English with previous recording experience. Two practice items preceded each recorded list. Inter-item intervals were approximately 3 sec. for the word and nonsense conditions; enough time to repeat the sentence twice (approximately 5 sec.) was left between sentences.

PROCEDURES

Groups of *S*s were pretrained at least a day before testing on the slides to insure the elicitation of the appropriate labels. The experimenter (*E*) presented slides with a Carousel projector and provided corrective feedback to the labels chorused by the group.

In individual testing sessions, slides were presented in a hand-held battery-operated viewer and taped materials were played through stereo earphones by a Uher 5000 tape recorder. Responses were recorded on a second Uher 5000 at 3 1/2 ips using a Shure lavaliere microphone.

Brief instructions to name or repeat preceded each condition. The order of conditions for a *S* within an age group was determined by sequential assignment of *S*s to rows in Latin-square blocks of the 24 possible orderings of picture, real word, nonsense word, and sentence. In the picture conditions, each *S* named the slides in two different random orders, with an intervening presentation in which *E* named the slides.

SUBJECTS

The 64 *S*s were drawn from University of Wisconsin students, first graders and kindergartners attending Nakoma Elementary School (an upper-middle class school in Madison, Wisconsin), and four-to-five year old preschoolers attending Child Development, Inc., day-care centers in Madison and Middleton, Wisconsin. The original design called for 24 *S*s in each age group; mechanical recording difficulties resulted in the loss of data for 32 *S*s. For the remaining *S*s in each age group, order of conditions was approximately counterbalanced. In the data reported here, 24 adults, 10 first graders, 8 kindergartners, and 22 preschoolers are represented.

DATA TRANSCRIPTION

Errors of pronunciation were independently transcribed in broad phonetic notation (IPA) by two experienced linguists; a third transcriber resolved any disagreements between the two transcribers.[2]

Pronunciations of real words attributable to dialect variation were treated as correct. These included post-vocalic /r/-deletion in *star, shirt, flowers, church,* and *scarf*; substitution of /a/ for /ɔ/ in *frog* or /ɔ/ for /a/ in *star* and *scarf*; and substitution of /a/ for /æ/ in *glass* and *grass*. The same criteria were applied to the nonsense list in order to provide comparable error scoring; post-vocalic /r/-deletion was accepted in /staʊəz/, /glət/, /šəθ/, and /marf/; /a/ or /ɔ/ was accepted in /čɔs/, /tram/, and /marf/; /a/ was accepted in /stræθ/ and /fræŋ/.

ERROR CLASSIFICATION

Substitution or deletion errors were classified according to whether they occurred in an initial consonant (IC) or initial consonant cluster (ICL); the vowel (V), including /ə/ as a single vowel phoneme; or final consonant (FC) or final consonant cluster (FCL). An insertion error was scored as a cluster error if it occurred medially in the cluster. A pre-vocalic insertion was classified as an IC (or ICL) error if the insertion was consonantal; if a vowel, it was classified as a V error. Similarly, a post-vocalic insertion was classified as a V or FC (FCL) error depending on whether it was a vowel or a consonant.

For each *S*, a percentage score for each of the five error types was derived by dividing the number of phoneme errors by the total number of phonemes for that classification and then multiplying by 100. Thus a score represented per cent error of total possible deletion and substitution errors. Insertion errors, which are not taken account of in computing the total possible error, were rare. The total number of phonemes for each error type in each stimulus list were: IC, 5; ICL, 21; V, 16; FC, 14; FCL, 2. When a *S* failed to produce the expected word or nonsense syllable, or when noise made the response unintelligible, the number of phonemes in each divisor was accordingly reduced.

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[2]IPA, or the International Phonetic Alphabet, is one of several systems for representing speech sounds in any language.

III
RESULTS

The mean per cent error for each age group, mode, and sound class in the 4 x 5 x 5 design is shown in Table 2. No errors were made on the two phonemes exemplifying the FCL sound class in any condition except the nonsense mode. It is clear, then, that FCL error rates would be significantly lower than all other sound class error rates in real word modes, and that the nonsense mode would differ significantly from the real word modes in FCL error rate. Thus a significant mode by sound class interaction could arise from FCL error scores alone. It was decided to test for additional sources of main effect and interaction by deleting the FCL sound class from the analysis of variance; college students' scores were also deleted.[3]

A 3 x 5 x 4 unequal-n analysis of variance, age group by mode by the remaining

[3]College *S*s were omitted from the analysis since it was possible that their relatively error-free performance might attenuate effects of mode and sound class present for the children.

Table 2

Mean Per Cent Error by Sound Class and Elicitation Mode for Each Age Group

Group	Mode	Sound Class				
		IC	ICL	V	FC	FCL
Preschool (n = 22)	Picture 1	9.8	6.3	5.4	3.1	0.0
	Picture 2	10.8	6.3	4.6	3.9	0.0
	Word	10.0	6.3	4.3	5.2	0.0
	Sentence	5.4	4.6	2.6	4.5	0.0
	Nonsense	7.3	5.4	12.0	16.9	20.4
Kinder-garten (n = 8)	Picture 1	15.4	1.3	2.4	4.1	0.0
	Picture 2	5.0	4.7	.9	4.7	0.0
	Word	10.0	1.2	0.0	.9	0.0
	Sentence	2.5	.6	.8	0.0	0.0
	Nonsense	7.5	3.6	4.7	13.4	12.5
First grade (n = 10)	Picture 1	4.0	1.4	1.2	.7	0.0
	Picture 2	4.0	1.4	0.0	0.0	0.0
	Word	6.0	1.4	1.3	2.1	0.0
	Sentence	2.0	.5	1.2	.7	0.0
	Nonsense	4.0	6.7	3.1	8.6	10.0
College (n = 24)	Picture 1	0.0	.6	0.0	0.0	0.0
	Picture 2	0.0	0.0	0.0	0.0	0.0
	Word	0.0	.2	0.0	0.0	0.0
	Sentence	0.0	0.0	0.0	0.0	0.0
	Nonsense	.8	.2	1.3	4.2	8.3

Table 3

Mean Per Cent Error by Sound Class and Elicitation Mode, Averaged over 40 Children

Mode	Sound Class					Average	Average without FCL
	IC	ICL	V	FC	FCL		
Picture 1	9.5	4.1	2.7	3.8	0.0	4.0	5.0
Picture 2	8.0	4.8	3.1	2.7	0.0	3.7	4.6
Word	9.0	4.0	3.6	2.7	0.0	3.9	4.8
Nonsense	6.5	5.4	14.1	8.3	16.2	10.1	8.6
Sentence	4.0	2.7	2.7	1.9	0.0	2.3	2.8
Average	7.4	4.2	5.2	3.9	3.2	4.7	

sound classes, with repeated measures on the last two factors, was run on the children's per cent error scores. Significant effects were found for age group (F (2, 37) = 5.06, $p < .05$), sound class (F (3, 111) = 4.99, $p < .01$), mode of elicitation (F (4, 148) = 12.31, $p < .01$), and the mode by sound class interaction (F (12, 444 = 5.84, $p < .01$). (Repeated measures effects were also significant, $p < .05$, when the Geisser-Greenhouse correction to degrees of freedom was applied.) No other interactions were significant.

The significant age group effect arose from a decrease in per cent error with increasing age. Average per cent error for a sound class (excluding FCL) in a mode was 6.7 for preschoolers, 4.1 for kindergartners, and 2.5 for first graders.

The average per cent error in a sound class is shown for each mode of elicitation condition in Table 3. The error rate in the nonsense condition was approximately twice those of the four real word conditions; three times greater, when the FCL sound class is included. A post-hoc Scheffè comparison showed the nonsense condition error rate to be significantly greater than the average of the real word conditions ($p < .05$, $df = 4, 148$).

The main effect of sound class would appear to arise from the overall greater error rate on IC phonemes.[4] The post-hoc Scheffè test of IC versus the average of the other sound classes, however, did not reveal a significant difference.

The significant mode by sound class interaction arose from an error pattern difference between the nonsense condition and all of the other conditions. When the nonsense mode is removed from the analysis, the interaction disappears. The FCL sound class was omitted from these analyses but, if included, would have contributed strongly to the interaction; FCL error rates were zero everywhere but the nonsense condition. The complete interaction is displayed in Fig. 1; each bar in that graph represents the difference between error rate for a single sound class and the average error rate, for a particular mode. In the real word modes, most errors are made on initial consonants, fewer on vowels and final consonants, and fewest on final consonant clusters. In the nonsense word condition, fewest errors are made on initial consonants and clusters and most on vowels and final consonant clusters. That is, the error pattern in the nonsense mode was the reverse of that found in the real word modes. In the college student data, few errors were observed except in the nonsense condition; there, as in the children's data, error rates increased in final position.

FAILURES TO ELICIT TEST WORDS

The test word was elicited from *S*s 98.2% of the time overall. In Table 4 is shown the percentage of times test words were not given out of the total opportunities to give them for each mode and group, including college students. The picture conditions account for 91% of the failures to elicit test words from *S*s; most failures resulted from the *S* giving an inappropriate label for a picture. Even when the appropriate labels were given by *E*

[4]For the 15 words used in this study, prior normative data from 162 kindergartners and 148 first graders also showed higher error rates for initial consonants than other sound classes. In studies where the same sounds or clusters are tested both initially and finally, however, error rates typically increased from initial to final position (Templin, 1957).

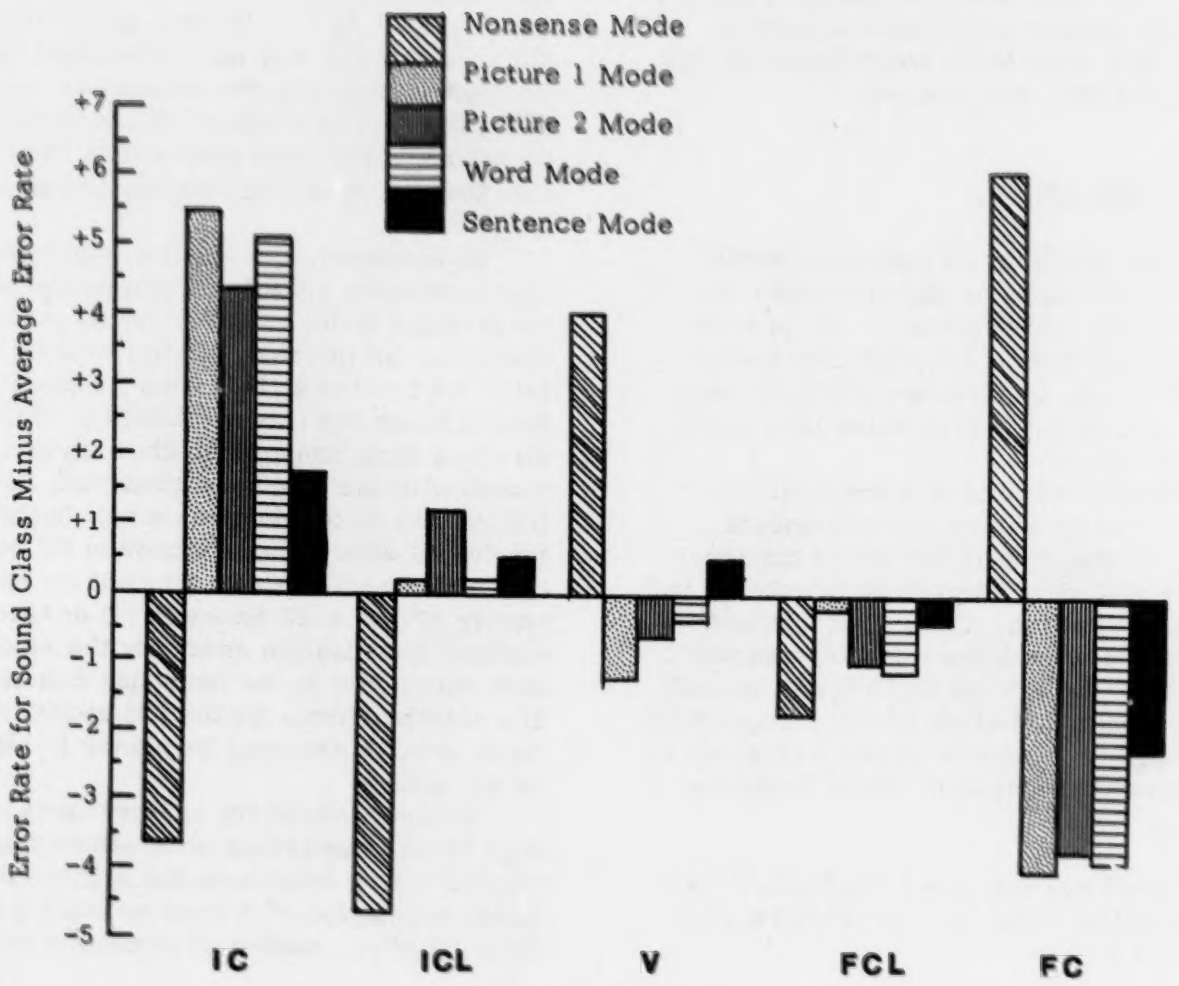

Fig. 1. Difference Between Error Rate for a Sound Class and Average Error Rate for Each Mode.

Table 4

Per Cent Failure to Give Test Word, by Group and Mode of Elicitation

(Preschool, n = 22; Kindergarten, n = 8; First Grade, n = 10; College, n = 24)

Group	Mode of Elicitation					All modes
	Picture 1	Picture 2	Word	Sentence	Nonsense	
Preschool	7.9	4.8	2.1	0.3	0.0	3.0
Kindergarten	9.2	5.8	0.0	0.0	0.0	3.0
First Grade	5.3	0.7	0.0	0.0	0.0	1.2
College	1.7	0.6	0.0	0.0	0.0	0.4
All Ss	5.3	2.7	0.7	0.1	0.0	1.8

immediately prior to the list (second picture condition), 5 to 6% of the test words were not appropriately elicited in preschool and kindergarten *Ss*. The word repetition mode is clearly preferable to picture elicitation for normal children, since error rates are comparable and more complete data are assured.

NONSENSE WORD ERRORS

The high error rate on nonsense words may arise from failure to perceive some phonemes correctly. To account for the present data, it must be further assumed that misperception of sounds in nonsense words is more likely for sounds in final position than those in initial position.

An indirect check of this explanation was carried out by asking an independent sample of 10 adults to listen to the nonsense word tapes and write down what they heard in conventional spelling. Consonant spellings were examined for evidence of misperception. *Ss* spelled /θ/ as *f* 8 out of 10 times as both IC and FC. Only one other spelling suggested IC misperception, and four others suggested FC misperception.[5] These data would predict an 18% error rate on IC items for college students (.8% obtained), an 8.5% error rate on FC (4.4% obtained) and 0 error rates on ICL and FCL (.2% and 8.3% obtained). The fit of predicted and obtained data is far from good; although /0/ in particular may have presented identification problems in the absence of meaning cues, the supposed errors of misperception do not show the same increase in final position that the nonsense articulation errors exhibit.

An alternate, and simpler, explanation is that short-term memory for the nonsense phoneme string decays rapidly during production, leading to an increase in error rate for the latter part of the string. One finding in particular bears out this explanation: deletion errors of final consonants show an unusual increase in the nonsense condition, accounting for 75% of the deletion errors occurring for the FC error type. [Nonsense FC substitution and insertion errors account for approximately 50% of such errors in FC position.] Further, substitution errors for the single FCL item occur only in the nonsense condition. The deletion errors for the ICL items, in contrast, occur with equal frequency in all elicitation modes.

A direct test of the memory-decay hypothesis for the increasing error effect could be carried out by examining the probability of mispronunciation of a final consonant as a function of the number of preceding phonemes.

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[5]The spellings were *ch* for initial /š/ and, in final position, *z* for /s/, *ng* twice for /n/, and deletion for /k/.

IV
SUMMARY AND CONCLUSIONS

The most striking finding of the study is that nonsense word stimuli yield an error rate that is not only higher than the error rate for phonologically similar real word stimuli, but that also increases sharply from initial to final position.

Misperception of the nonsense stimuli was rejected as an explanation of the nonsense data, since indirect evidence indicated it could account only for a general error rate increase rather than the pattern of increasing errors observed. The hypothesis of short-term memory decay was advanced as a simpler explanation of the increasing error effect. On this explanation, word meaning would eliminate short-term decay of phonological information for real words, since the word is stored as a single unit which is used to retrieve phonological (or production) information from long-term memory. Although the alternative possibility of better phonological chunking of familiar phoneme sequences cannot be ruled out, it appears implausible in the face of evidence that listeners sharply differentiate nonsense English words from non-English words but not from real English words.

Further research is required to establish the extent and probable cause of the increasing error effect in nonsense word repetition. It is clear from the present data, however, that articulation test makers should take exceptional care in avoiding test words likely to be unknown to the children being tested. When two groups differing in size and structure of vocabulary (e.g., upper and lower socio-economic status children) are compared on the same articulation test lists, differential articulation scores may be found solely because more test words constitute nonsense items for one group. Reported correlations of articulation scores with socio-economic status and I.Q. must be viewed with some skepticism until it can be established that the test words were equally familiar to all children tested. Theoretical conclusions as to the relative difficulty of initial and final sounds are, of course, also biased by the inclusion of nonsense test items.

The failure to find different error rates or error patterns among the three real word elicitation modes leaves the choice of mode open on these counts. The repetition modes, however, allow a wider choice of test word and a higher probability of elicitation than the picture elicitation technique. Testing with single words has the advantage of shortening test time; testing with sentences confers more semantic context and the possibility of varying a test word's phonetic environment.

Finally, it should be noted that the data lay to rest again the speculation that children are significantly more likely to mispronounce spontaneously produced words than to mispronounce imitated words. Also unsupported by the data is the extension of that argument to predict higher error rates for repetition of words in sentences than for repetition of words in isolation.

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